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(54) Apparatus for Determining the Active Oxygen Content of Molten Metal

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APPARTUS FOR DETERMINING THE ACTIVE OXYGEN CONTENT OF MOLTEN METAL

Abstract

The invention relates to apparatus for determining the active oxygen content of molten metal. A measuring head is secured to the end of a supporting tube and comprises a ceramic material in which there is disposed an electrochemical cell such as a zirconium oxide material and a reference material. The electrochemical cell is completely provided with a jacket which prevents the penetration of moisture and which may be partially comprised of a metal shock shield bearing tightly against the zirconium oxide material.

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The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Apparatus for determining the active oxygen content of molten metal comprising a measuring head adapted to be secured to the end of a supporting tube, the head including a ceramic material in which there is disposed an electrochemical cell, characterized in that the electrochemical cell is provided with a jacket which prevents the penetration of moisture during manufacture and storage, a portion of said jacket being meltable on immersion of the apparatus into the molten metal.

2. Apparatus for determining the active oxygen content of molten metal comprising a measuring head adapted to be secured to the end of a supporting tube, the head including a ceramic material in which there is disposed an electrochemical cell including a zirconium oxide material, characterized in that the electrochemical cell is provided with a jacket including a metal shock shield bearing against the zirconium oxide material, said jacket prevents the penetration of moisture during manufacture and storage.

3. Apparatus according to claim 2, characterized in that the zirconium oxide material is in the form of a tube over which the shield is telescoped, and a portion of the zirconium oxide tube projecting from the shield, said projecting portion being provided with a plastic covering.

4. Apparatus according to claim 2, characterized in that the shield has at least the same length as the zirconium oxide material which is in the form of a tube with its bottom open end provided with a closure which prevents the penetration of moisture.

5. Apparatus according to claim 4, characterized in that the shield projects from the bottom open end of the zirconium oxide tube and the closure is constructed in the form of a stopper which bears against the inner surface of the shield and projects into the zirconium oxide tube by a reduced-diameter portion.

6. Apparatus according to claims 4 or 5, characterized in that the closure is made from silicone rubber.

7. Apparatus according to claim 2, characterized in that the zirconium oxide material is in the form of a disc disposed in a front opening in the ceramic material above a reference material, the metal shock shield being of disc-shape and secured to the zirconium oxide disc on the side of the disc nearest the front of the opening, the jacket lining the walls of the front opening in the ceramic material to encase the zirconium oxide material and reference material to prevent penetration of moisture.

8. Apparatus according to claim 1 characterized in that air has been sucked out of the cell and replaced by an inert gas.

APPARTUS FOR DETERMINING THE ACTIVE OXYGEN CONTENT OF MOLTEN METAL

Background

In some cases, practical use of prior art devices has resulted in incorret measurements, for which no explanation could initially be found. The object of the invention is to ensure that incorrect measurements are reliably avoided.

The invention is based on the finding that the malfunctions that have occurred are due to the presence of moisture in the cell, particularly in the reference material. The cell absorbs moisture because of the porosity of the zirconium oxide tube or zirconium oxide disc, and via the filler material, which usually consists of Al_2O_3. Other moisture originates, for example, from the cement by means of which the measuring head is filled and secured.

Summary Of The Invention

Starting from apparatus of the kind described hereinbefore, and on the basis of the above finding, which must be regarded as surprising, the solution to the problem as provided by the invention is that the electrochemical cell is completely provided with a jacket which prevents the penetration of moisture during manufacture and storage.

This invention relates to apparatus for determining the active oxygen content of cast iron, iron or steel melts. A measuring head is secured to the end of a supporting tube. The head includes a ceramic material in which there is disposed an electrochemical cell comprising a zirconium oxide material and a reference electrode. The cell is provided with a metal shock shield which shields the electrochemical cell from the melt and is destroyed on immersion of the measuring head into the molten metal.

In one embodiment of the apparatus the zirconium oxide material is in the form of a tube projecting from the body of ceramic material. The reference material is disposed in the tube. The shield is also in the form of a tube and having at least the same length as that portion of the tube of zirconium oxide material which projects from the ceramic material. The shield is adapted to be pushed on to the tube of zirconium oxide material and the inside diameter of the shield corresponds practically to the outside diameter of the cell tube so that the shield bears tightly against the electrochemical cell.

In another embodiment of this apparatus known from German Offenlegungsschrift 2 824 143, of June 24, 1982 to Electro-Nite Company the zirconium oxide material is in the form or a disc which rests on the reference material in a front opening in the ceramic material. In this case the shield is of disc-shaped construction, rests on the top surface of the zirconium oxide disc, and is secured by a suitable bonding agent, preferably refractory cement. Thermal shocks can be avoided by means of apparatus of this kind, which is very simple in construction.

Of course the air contained in the cell should contain as little moisture as possible. To this end, the reference material and the zirconium oxide material can be dried beforehand. It has also been found advantageous for the air contained in the cell to be removed after the jacket has been fitted, and for it to be replaced, possibly

by an inert gas, e.g. argon. In this way, the reference material is protected from the oxidizing action of the air during storage. To this end, according to the invention, the jacket and/or the closure is/are provided with an extraction means, preferably an extraction spigot, via which the air is sucked out of the cell and which after the suction or after introduction of an inert gas is closed by pinching and/or heating.

By means of the apparatus according to this invention it is possible to avoid the penetration of moisture to the interior of the cell and to protect the reference material therefrom so as to reliably preclude incorrect measurements due to the penetration of moisture.

Three exemplified embodiments of the invention are illustrated diagrammatically in the drawing wherein:

For the purpose of illustrating the invention, there is shown in the drawing a for which is presently preferred; it being undertsood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

Figure 1 is a section through a measuring head in accordance with one embodiment.

Figure 2 is also a section showing another type of jacketing of the zirconium oxide tube in accordance with another embodiment.

Figure 3 is a vertical section through the top portion of a measuring head in accordance with another embodiment wherein the zirconium oxide material is in the form of a disc.

Detailed Description

The bottom part of the measuring head 1 shown in Figure 1 contains a plug system for connection to a measuring lance in a known manner. Reference 11 denotes the ceramic body accommodating the actual measuring cell 2 and a thermocouple 9. The electrochemical cell 2 com-

prises a zirconium oxide tube 3. The reference material 4 is disposed in the top closed portion of tube 3. The remainder of the tube 3 is filled with a filler 5, preferably of aluminum oxide (Al_2O_3).

A conductor 6, e.g. a molybdenum wire, which terminates inside the reference material 4, extends through the filler 5 as far as the plug system. The zirconium oxide tube 3 is surrounded by a metal shock shield 8, which bears tightly against the tube 3 and is a metal such as low carbon steel which melts on immersion into the molten metal bath. At its bottom open end the shield 8 projects slightly beyond the zirconium oxide tube 3 and is provided with a moisture prevention closure 7, through which the conductor 6 is tightly passed and which tightly seals the bottom end of the zirconium oxide tube 3.

In the embodiment illustrated in Figure 1 of the drawing, a reduced-diameter portion of the closure 7 projects slightly into the zirconium oxide tube 3 while the larger-diameter portion bears tightly against the inner surface of the shield 8. Reference 10 denotes a protective cap which is conventionally used in measuring devices of this kind and which may be, for example, of cardboard or alternatively of metal. Closure 7 is preferably silicone rubber but other materials may be used.

The zirconium oxide tube may alternatively be encased in the manner shown in Figure 2, in which like or primed reference numerals are used for like parts with respect to the above-explained device shown in Figure 1. In the second embodiment, the zirconium oxide tube 3 is again surrounded by a metal shield 8' bearing tightly against it but the shield 8' does not extend as far as the bottom open end of the zirconium oxide tube 3. For example, shield 8' extends over only two-thirds of the length of tube 3. The bottom portion of the tube 3 is surrounded by a jacket 12, e.g. of plastics, to prevent the penetration of moisture. The jacket 12 extends

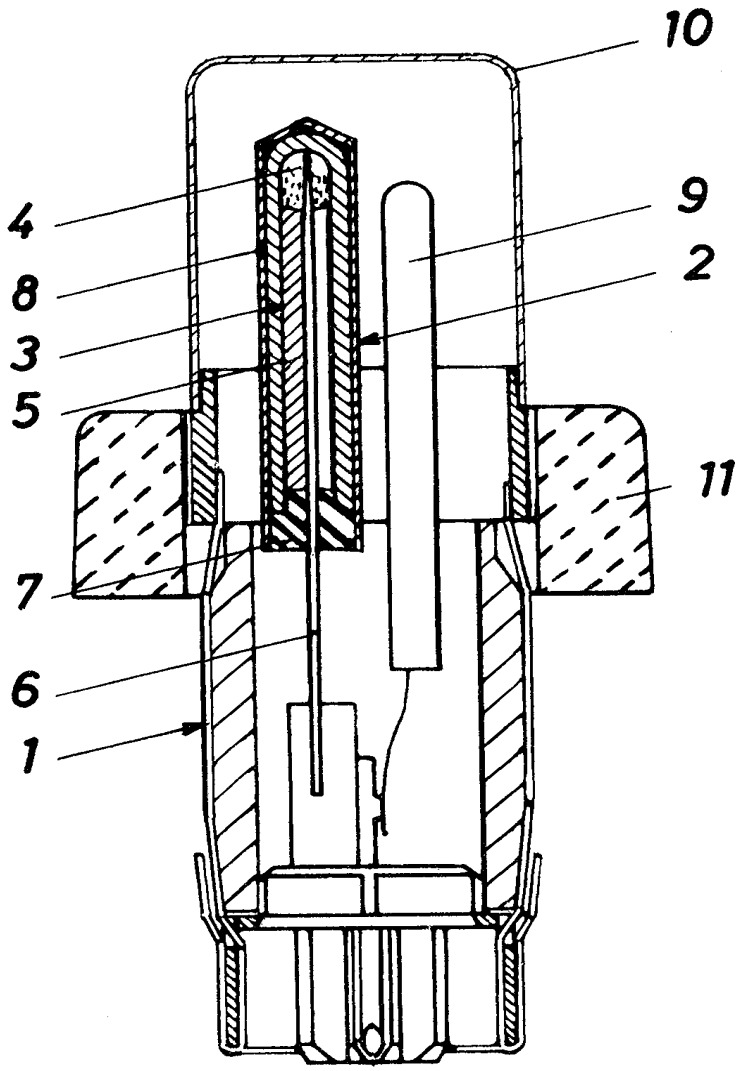
slightly above the open end of the shield 8' to give a perfect seal. Closure 7' seals the bottom end of the zirconium oxide tube 3 and preferably is made of silicone rubber.

Figure 3 illustrates an embodiment in which the zirconium oxide compound is in the form of a disc 13 disposed in a front opening 17 in the ceramic member 11'. A metal shield 14, which is also of disc-shaped construction, rests on the top surface of the zirconium oxide disc 13 and is secured to the ceramic member 11' by a suitable bonding agent, preferably refractory cement or lute. The front opening of ceramic member 11' also contains the reference material 15 in which the conductor 16 terminates. The entire front opening 17 of the ceramic member 11' is provided with a jacket or lining 18 which completely surrounds the electrochemical cell and prevents the penetration of moisture.

In each embodiment the air in each cell has preferably been evacuated and replaced with an inert gas as described above.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

Fig. 1



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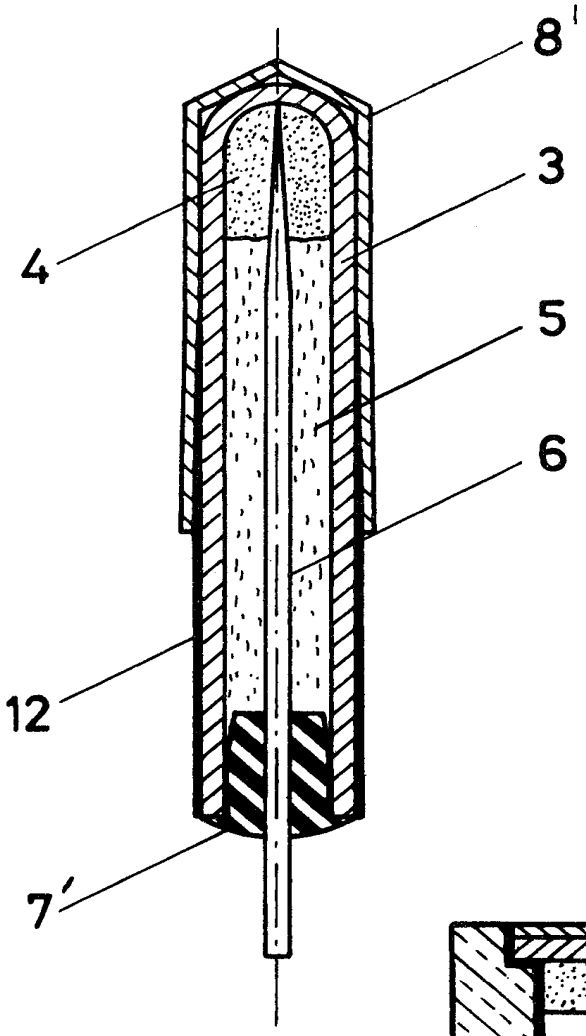
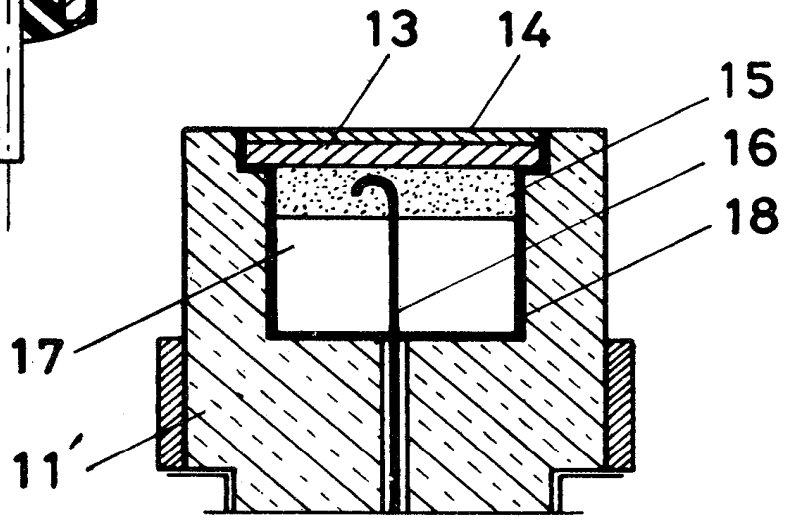


Fig. 2

Fig. 3



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